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THE EFFECT OF EXTERNAL MAGNETIC FIELD ON DYNAMICS OF TWO-DIMENSIONAL ISOTROPIC MHD

Abstract

Magnetic fields influence many natural and man-made flows. They are routinely used in industry to heat, pump, stir and levitate liquid metals. There are also many natural phenomena affected by the magnetic field. Although there is no such thing as two-dimensional turbulence, and indeed it is true that all real flows are three dimensional, certain aspects of certain flows can be considered 'almost' two-dimensional. For example, the depth of the troposphere is very low compared to the atmosphere therefore the third dimension can be ignored if the large-scale investigation is desired. Also, in the laboratory or some industry, a strong magnetic field or intense rotation tends to suppress one component of motion. Magnetohydrodynamics, or MHD, is a branch of the science that studies the interaction between magnetic fields and moving conducting fluids. In this article, the impact of external uniform magnetic field is investigated on the dynamic characteristics and mixing parameters of two-dimensional isotropic MHD flow. For this purpose, the direct numerical simulation (DNS) is applied to two-dimensional incompressible Navier-Stokes and magnetic induction equations by pseudo-spectral method. Governing equations are considered in the N-S vorticity equations to guarantee the incompressibility condition and remove the pressure term from equations. The effects of the magnetic field and magnetic diffusivity on dynamic characteristics of flow are explored by simulation of MHD with imposed uniform and constant external magnetic field. Moreover, calculations show that the deformation of vortexes by external magnetic field reduces the mixing efficiency. It is also demonstrated that in MHD flow the energy is exchanged by Lorentz force between the flow and the magnetic field in such a way that kinetic energy decreases and consequently mixing of the fluid is reduced. This energy transfer causes reduction of viscous dissipation of energy and mixing efficiency despite of increasing total dissipated energy rate.